NASA Ames Water Recycling Technology Development

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Advanced Life Support

Objective:

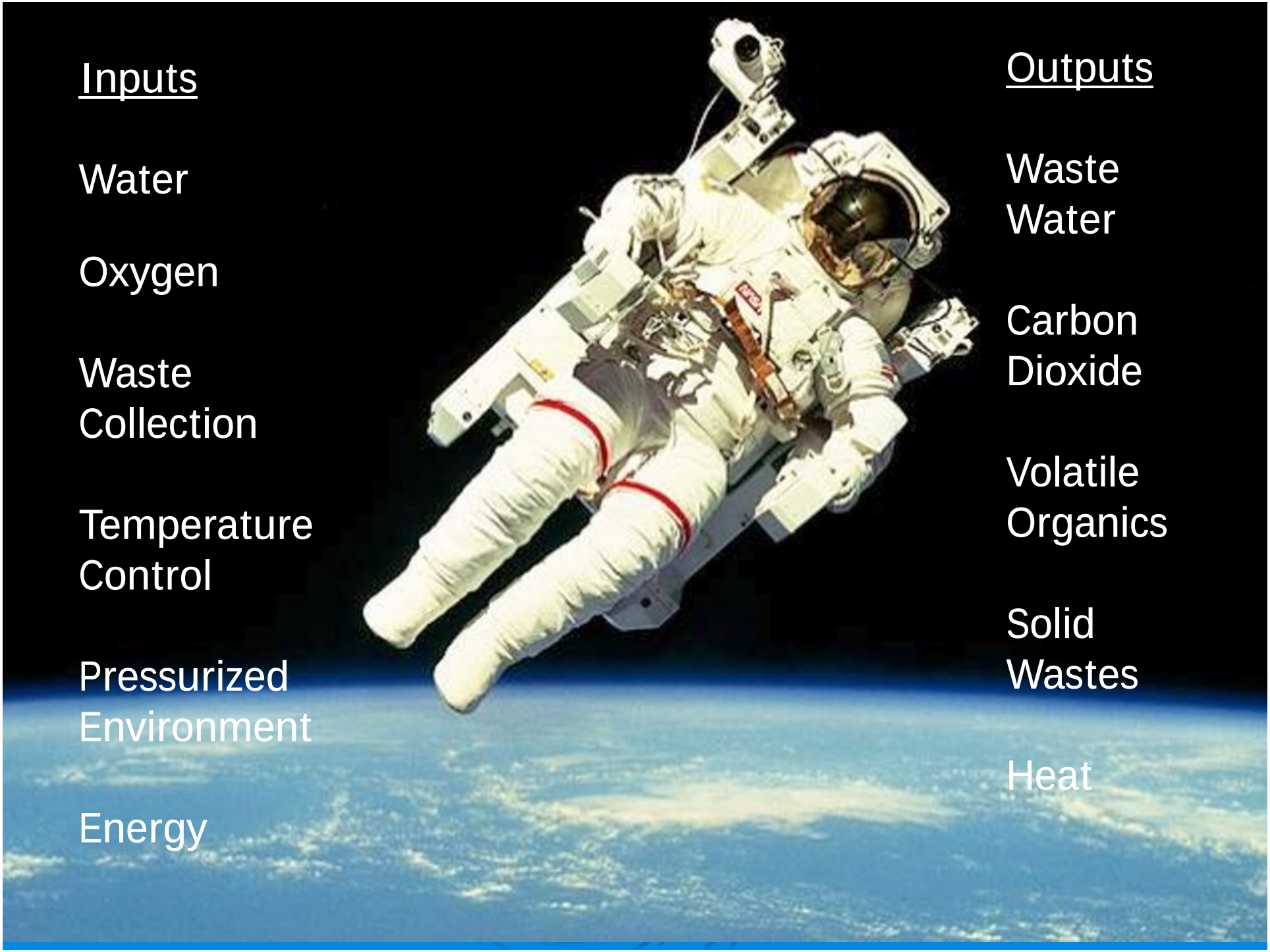
Keep Astronaut alive

Provide habitable environment

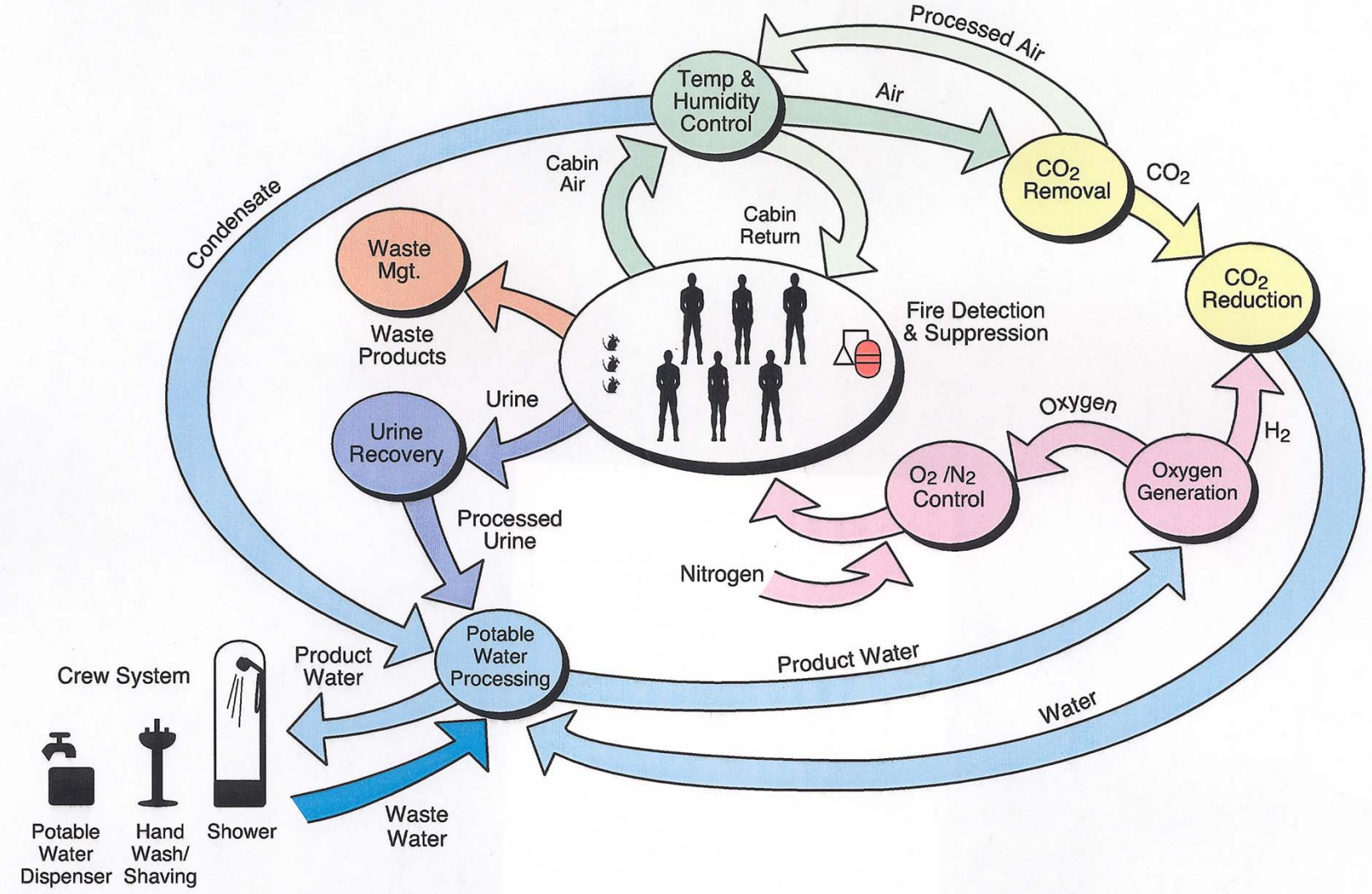
Reduce Cost

International Space Station

Mars


Inputs
Water
Oxygen
Waste Collection
Temperature Control
Pressurized Environment
Energy
Outputs
Waste Water
Carbon Dioxide
Volatile Organics
Solid Wastes
Heat

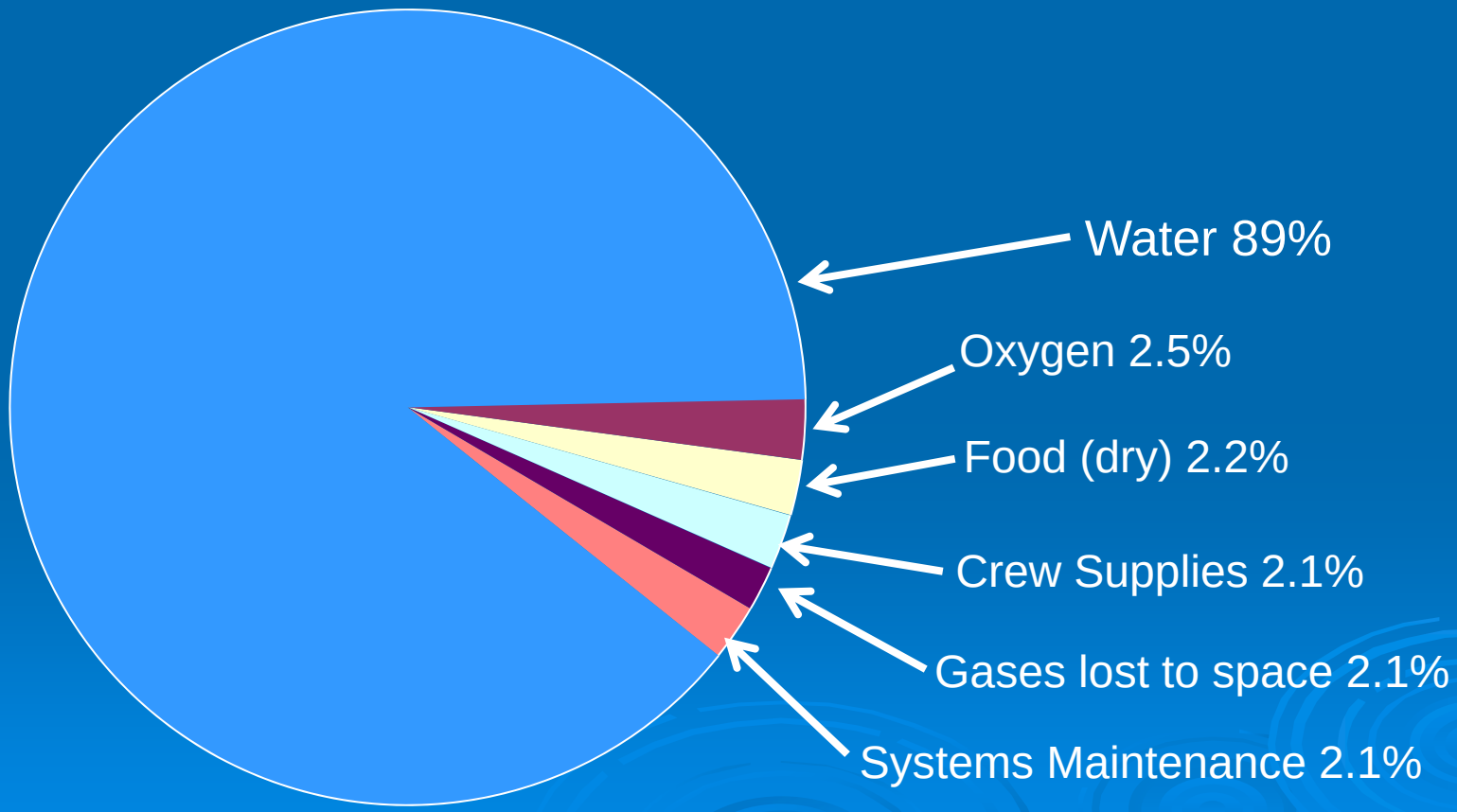
Space Station Regenerative ECLSS Flow Diagram (Baseline and Scarring)



MSFC/5-23920

Life Support Requirements

Open-loop life support system re-supply mass



ISS US Water Processing Assembly

- Wastewater is recycled using distillation, adsorption, and oxidation.
- Urine, hygiene, and condensate are recycled to drinking water.

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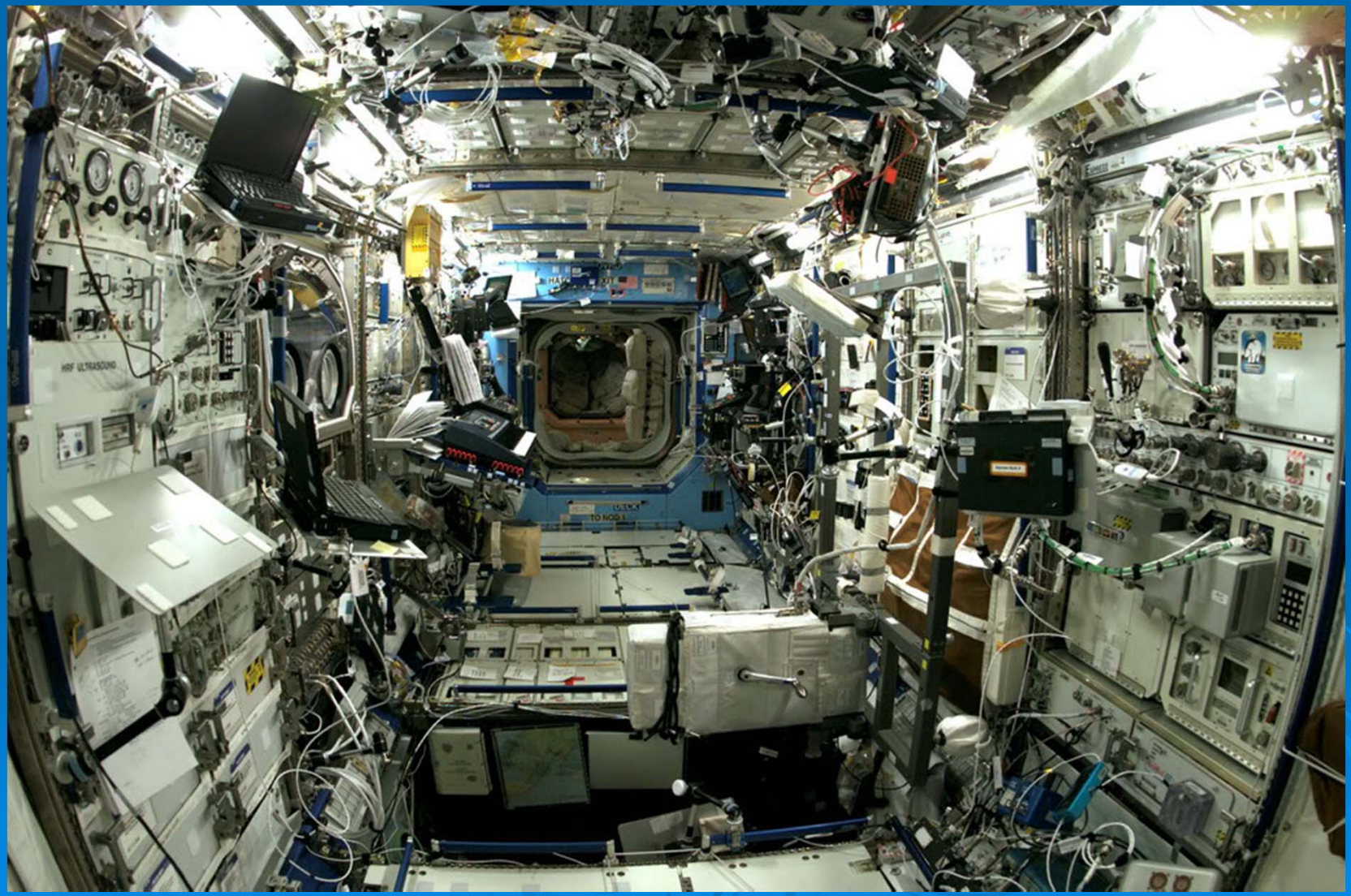
Concept to Practice

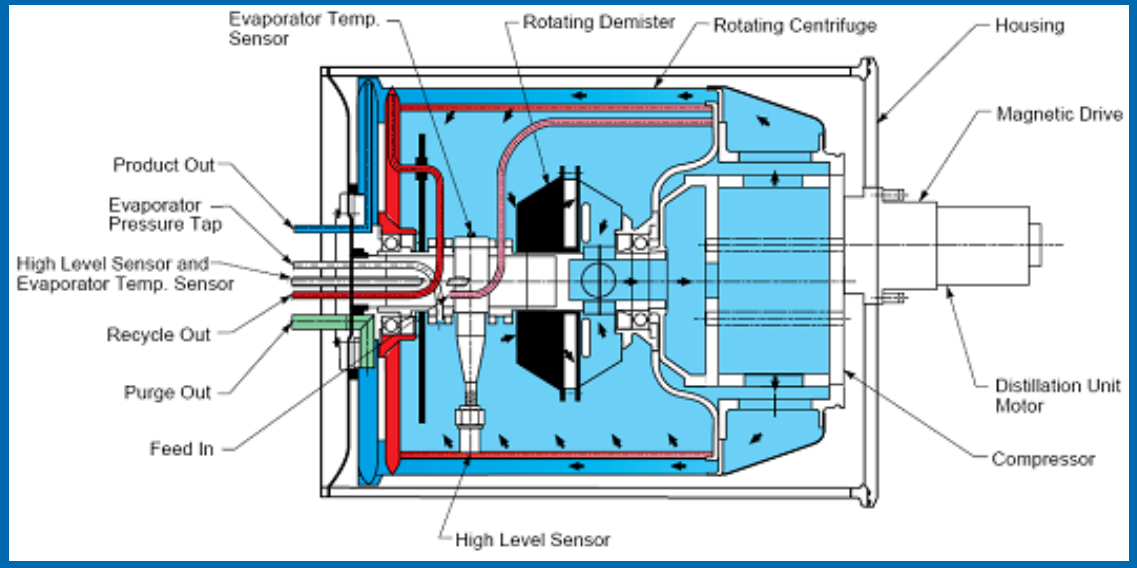
It is one thing to talk about what could be done but entirely another to make it work



ISS Urine Processing Assembly

Based on vapor compression distillation

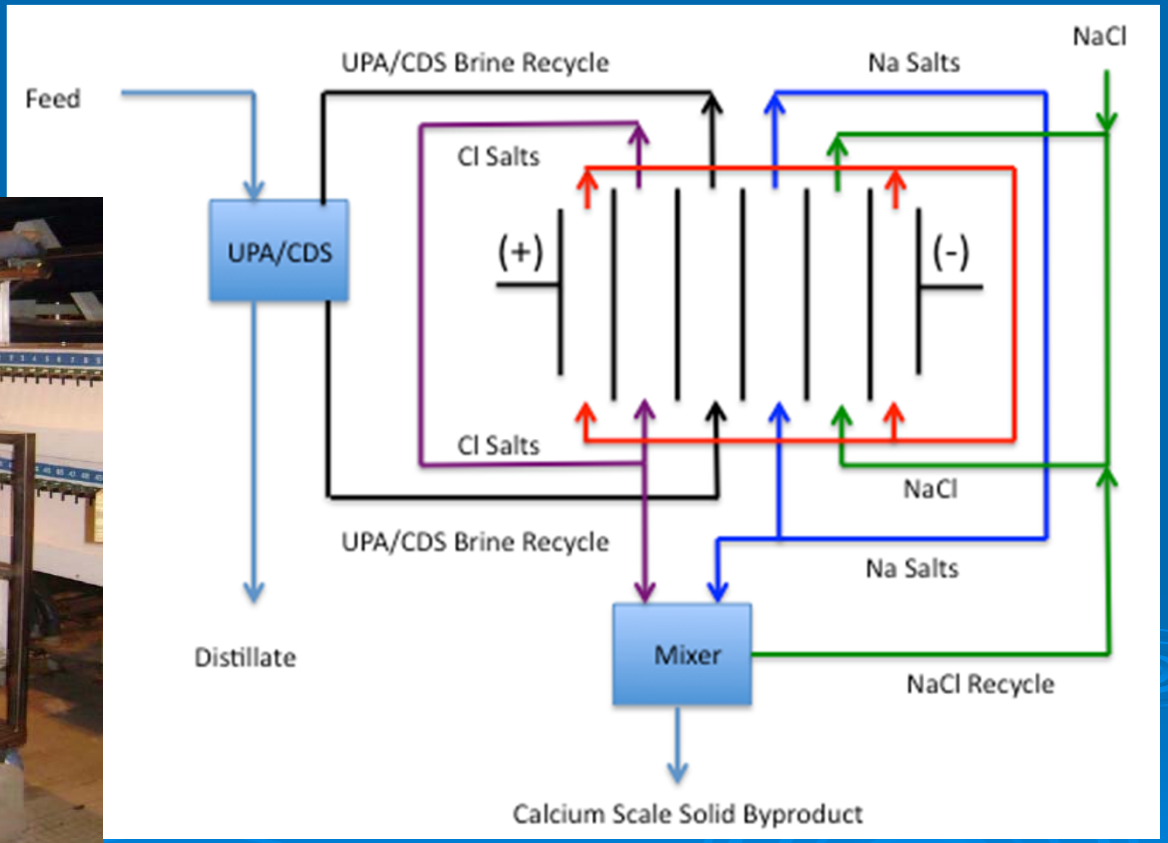
Susceptible to calcium scaling



Two types of calcium sulfate scale

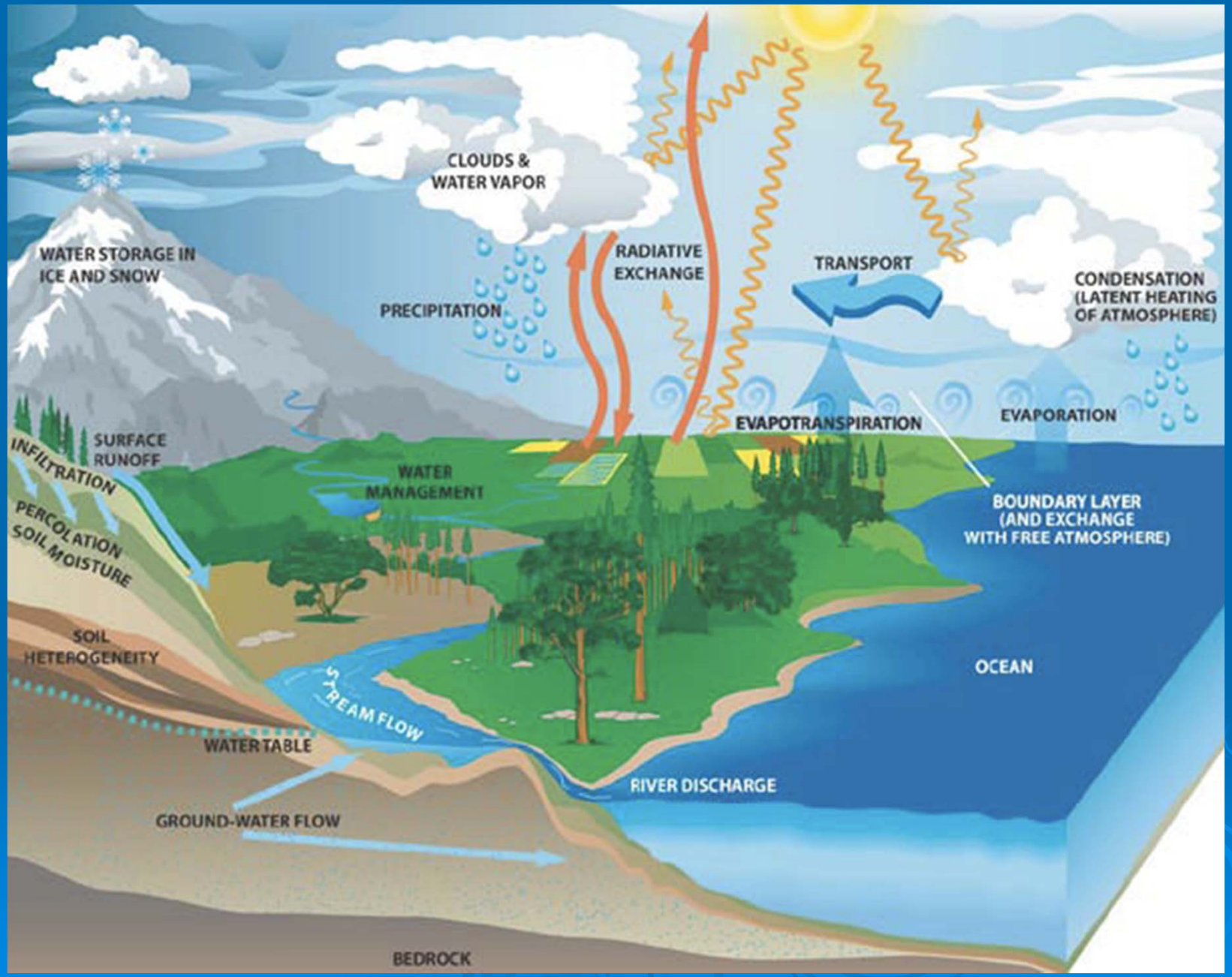
Electrodialysis Metathesis

EDM test stand

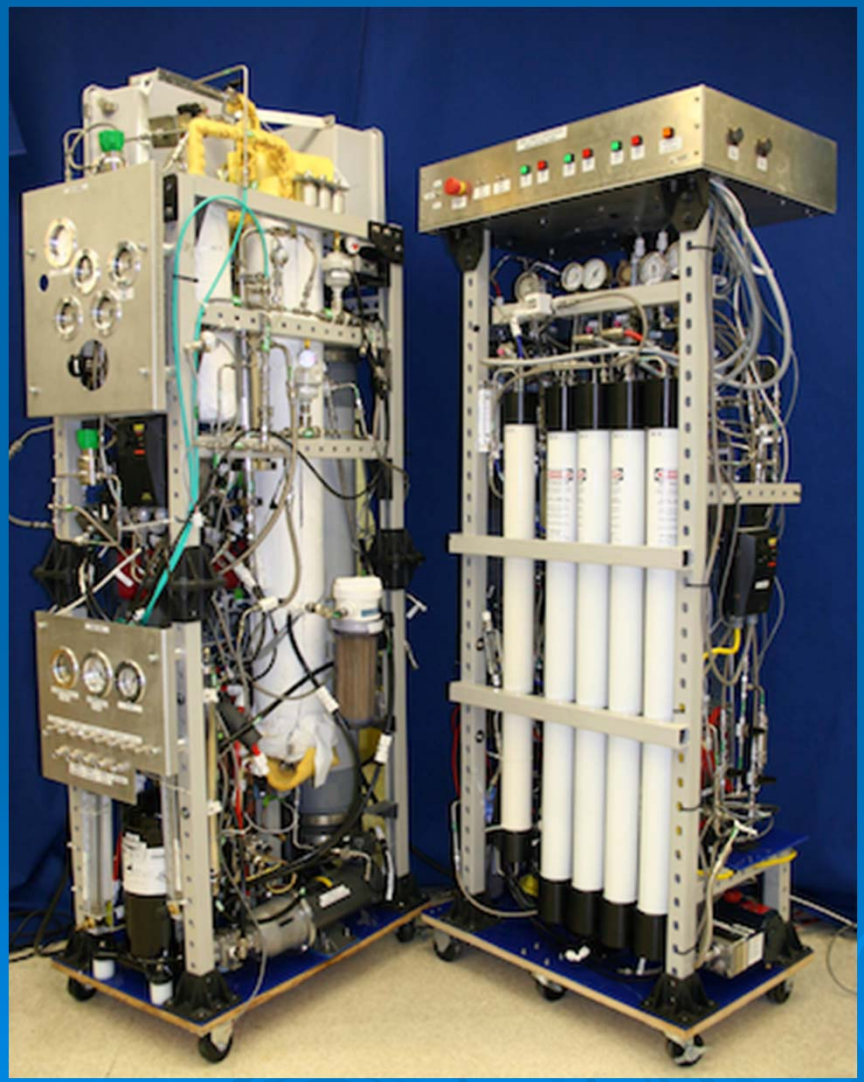


EDM Flow Diagram

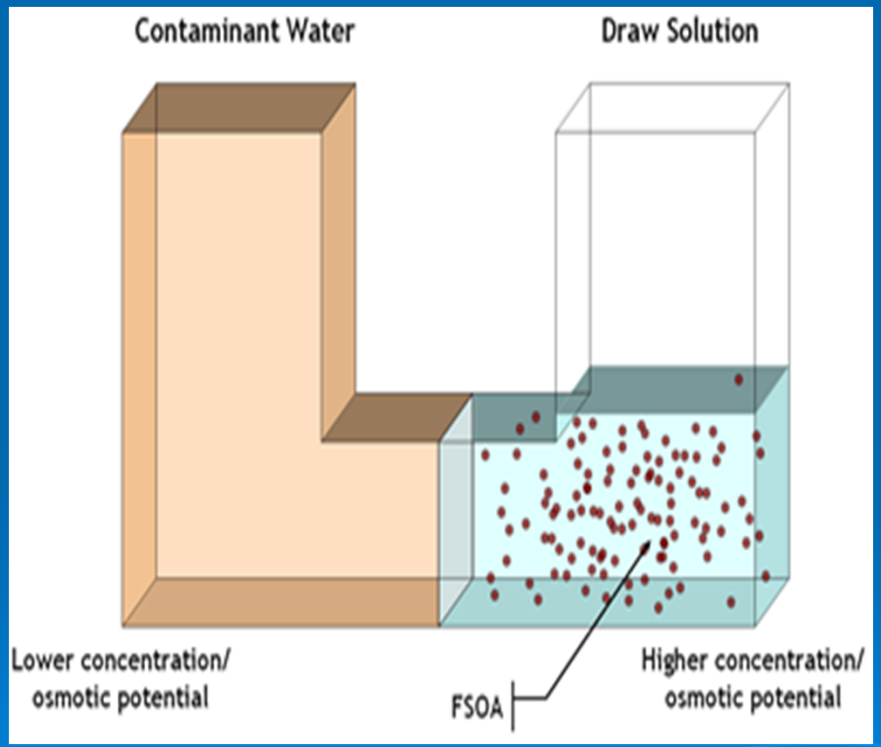
Vapor Phase Catalytic Ammonia Reduction

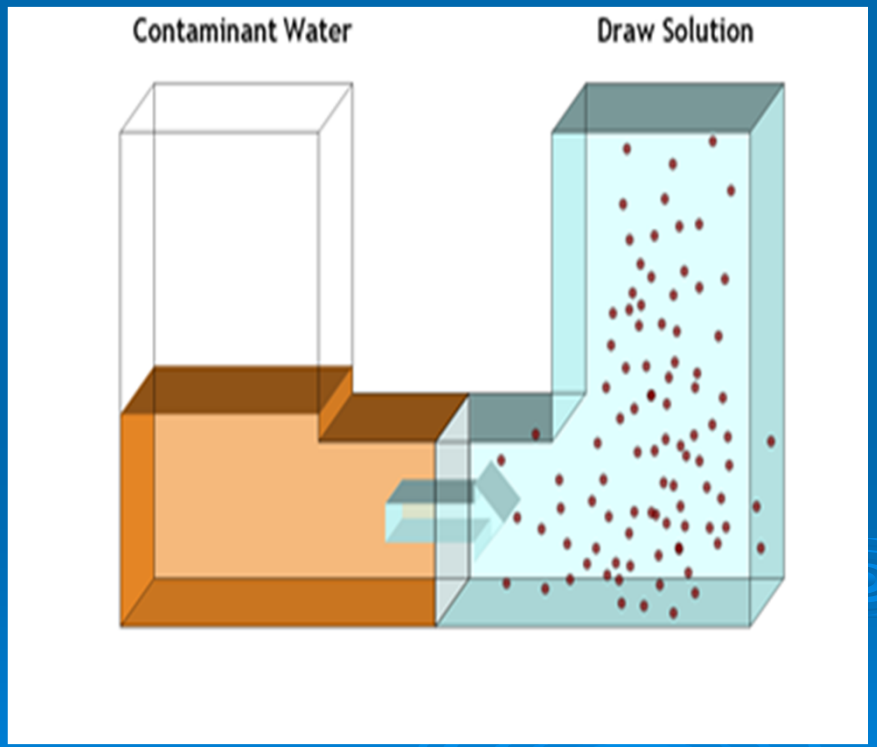

CLOUDS &
WATER VAPOR
WATER STORAGE IN
ICE AND SNOW
PRECIPITATION
RADIATIVE
EXCHANGE
TRANSPORT
CONDENSATION
(LATENT HEATING
OF ATMOSPHERE)
SURFACE
RUNOFF
INFILTRATION
PERCOLATION
SOIL MOISTURE
WATER
MANAGEMENT
EVAPOTRANSPIRATION
EVAPORATION
BOUNDARY LAYER
(AND EXCHANGE
WITH FREE ATMOSPHERE)
SOIL
HETEROGENEITY
STREAM FLOW
OCEAN
WATER TABLE
RIVER DISCHARGE
GROUND-WATER FLOW
BEDROCK

Forward Osmosis

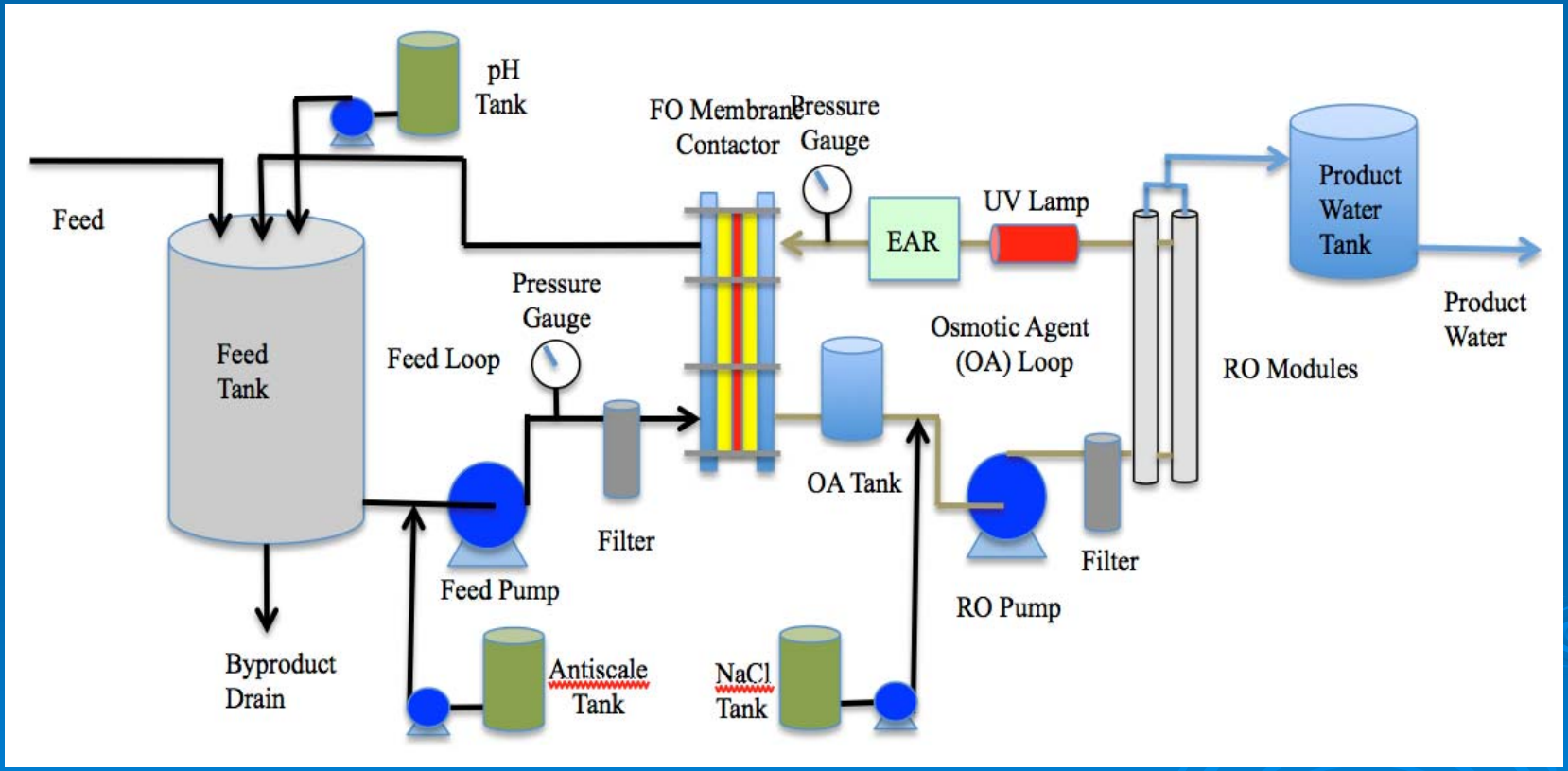


Forward Osmosis

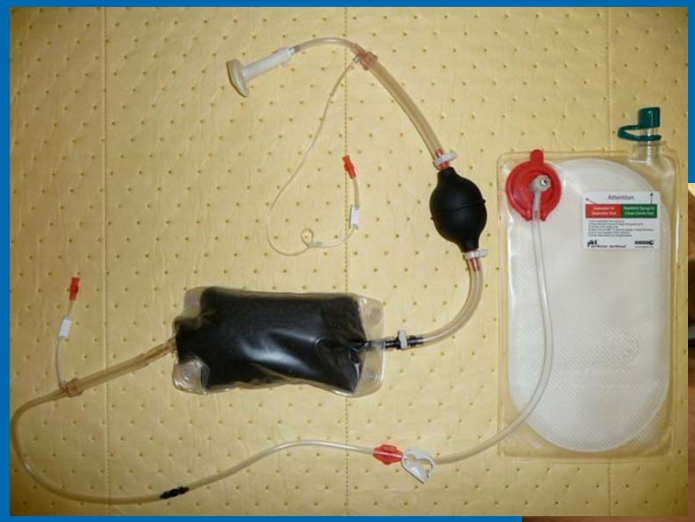




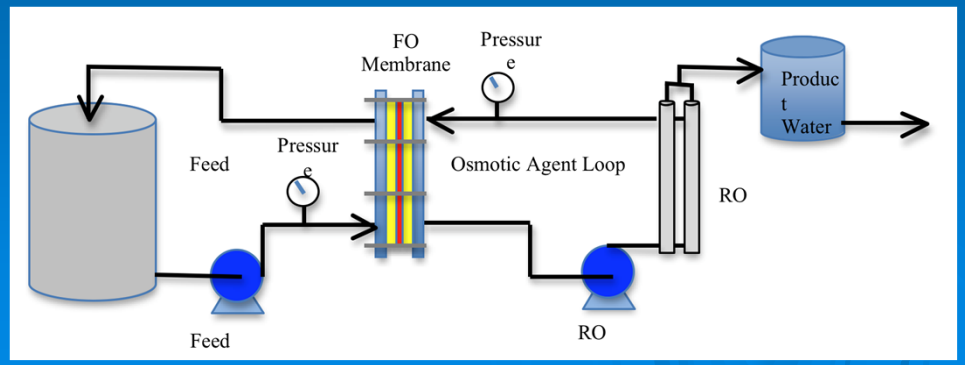
Forward Osmosis Secondary Treatment



Light Weight Contingency Water Recycling System

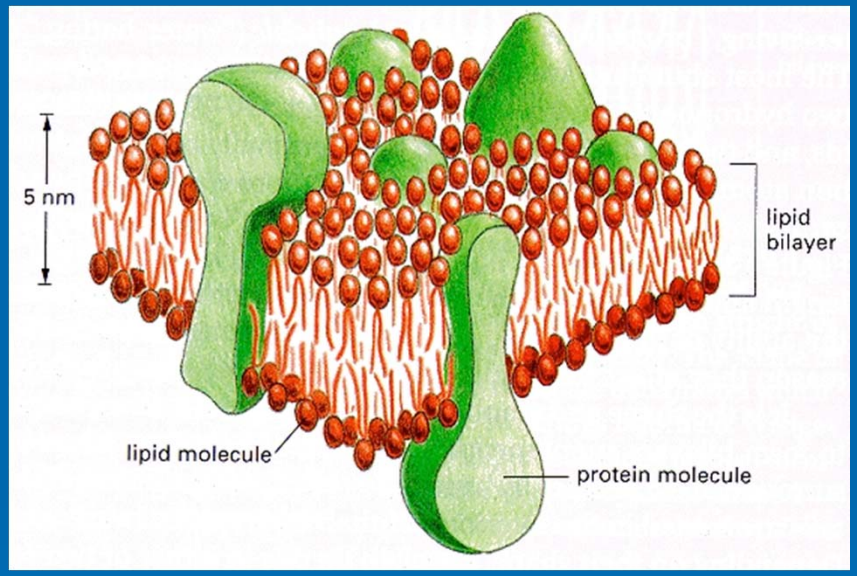


Graywater Recycling



Osmotic Distillation

Advanced Membranes

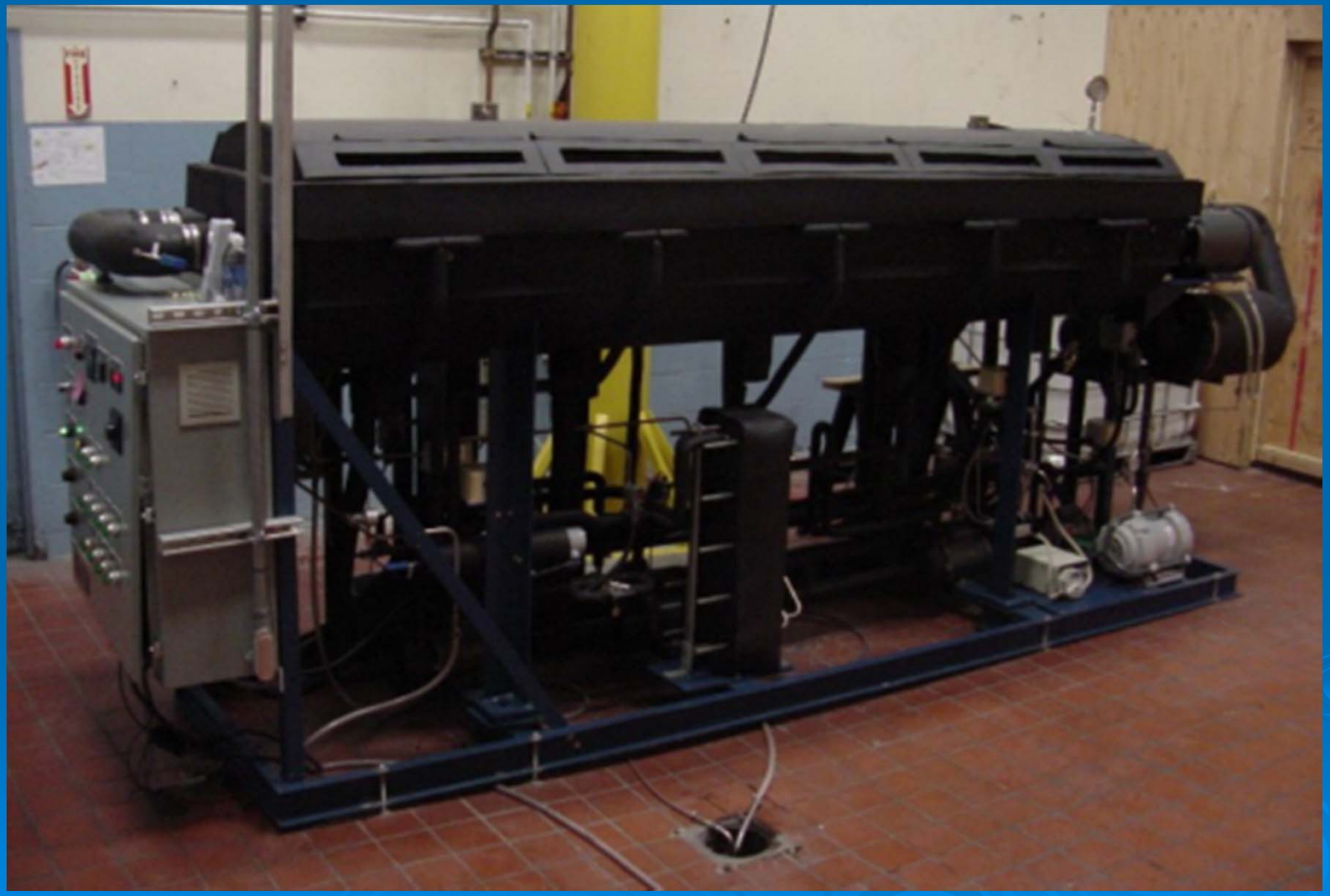


Lipid Bilayer Membranes

Aquaporin Embedded Protein Membranes

Glass Membranes, Nano-tube Membranes, Osmotic Solids, and Novel Backings

Food Processing

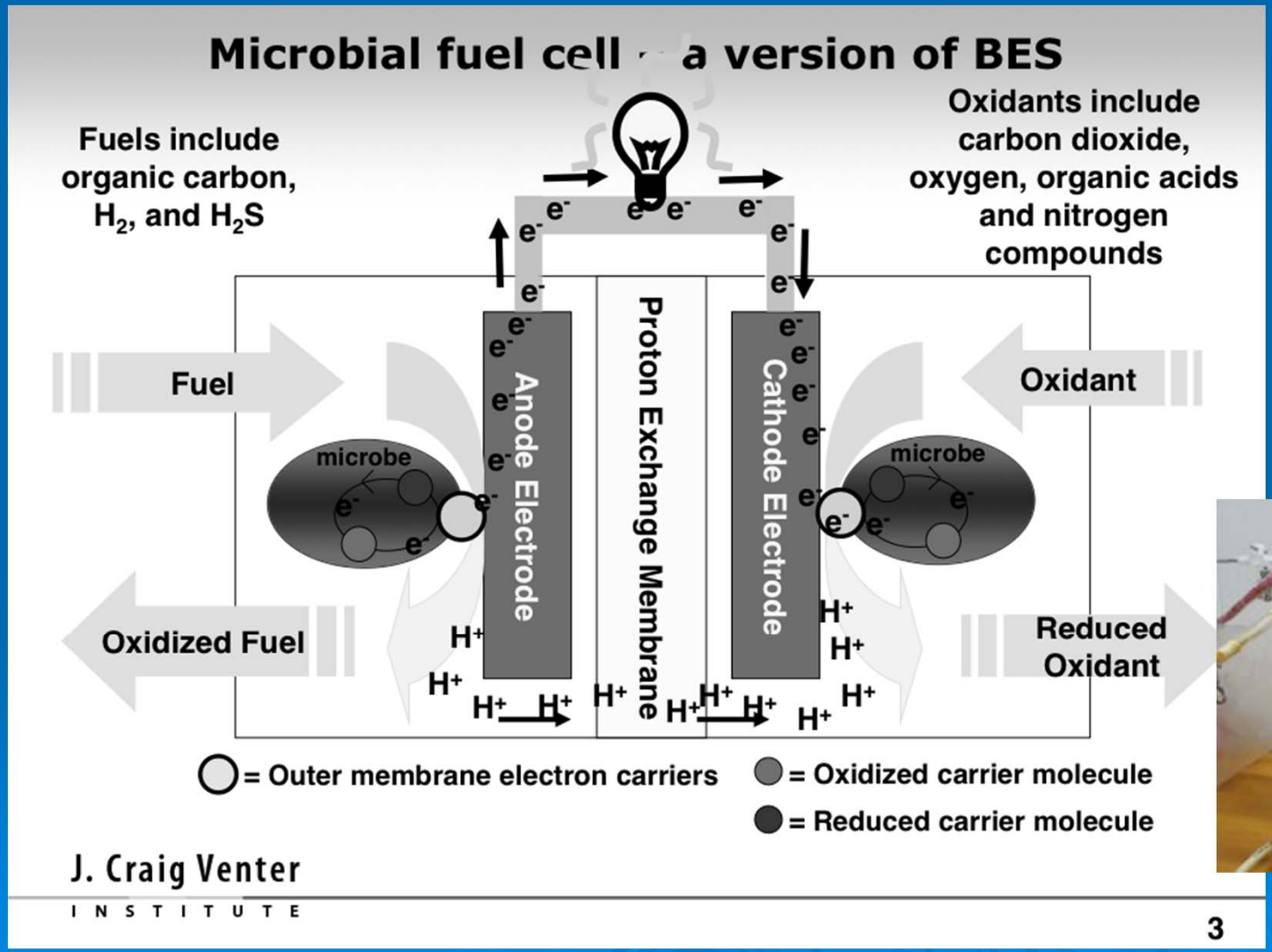


Wiped Film Rotating Disk Evaporator

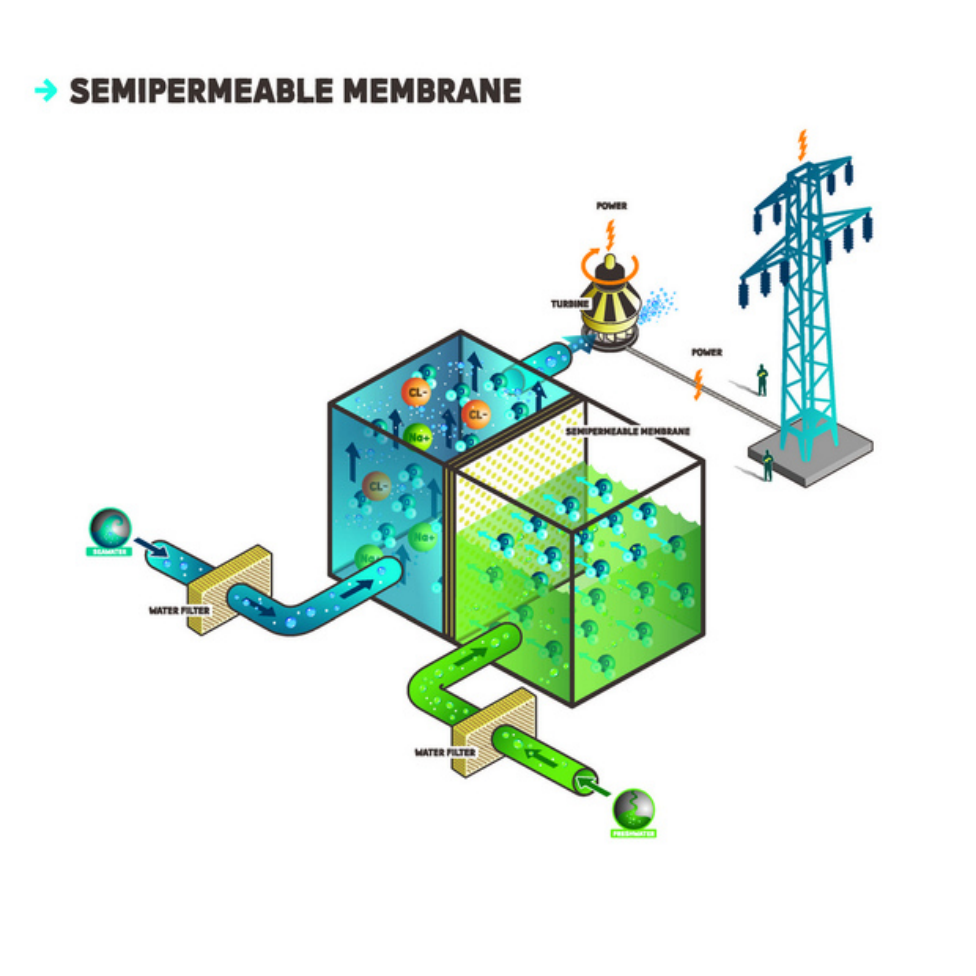
Seawater Desalination

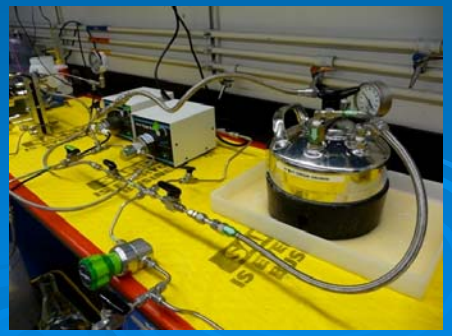
Environmentally Sustainable Desalination

Biological Fuel Cells



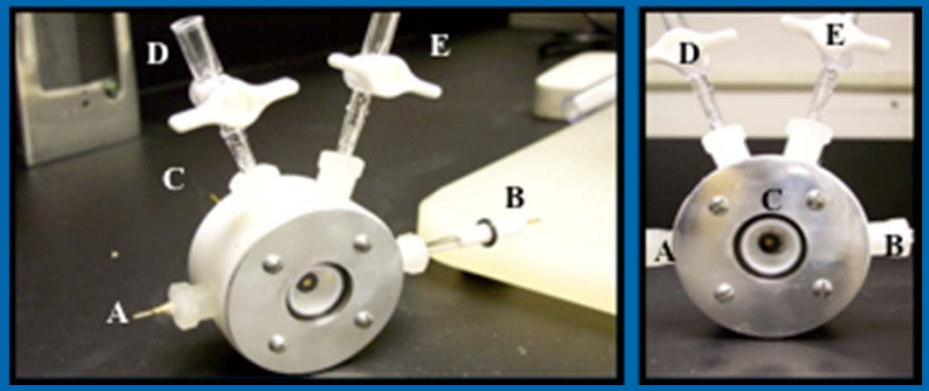
Osmotic Power

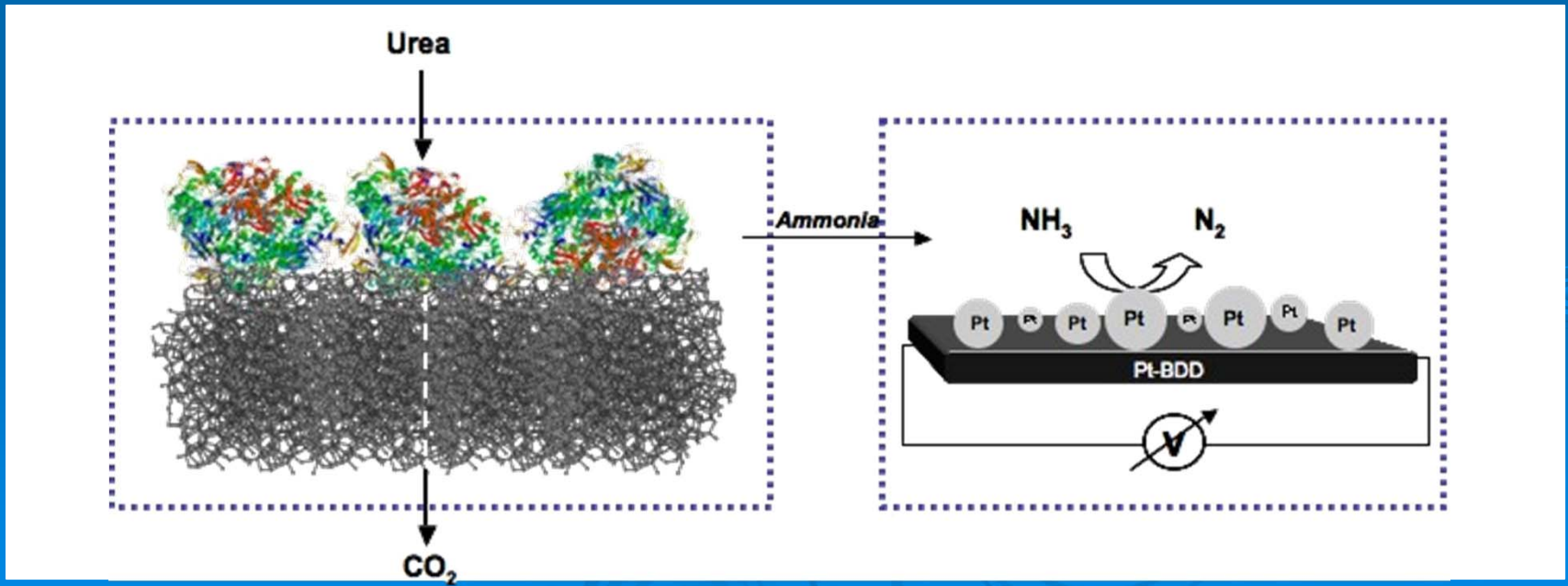




Ammonia Fuels and Cells

Urea Biofuel Cell Reactor for Water Purification





Water Recycling for Third World Applications